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OFFICE AUTOMATION COST/BENEFIT EVALUATION
A METHODOLOGY

by

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Office automation has been credited as a means by which office and organizational productivity can be increased. Incorporation of office automation technology can represent a large investment for any organization. To guarantee the proper allocation of resources, government managers and executives must utilize evaluation techniques which insure that the benefits of a program outweigh the costs. Naval Laboratories have been planning to purchase office automation technology to increase their productivity. To insure that the benefits of office automation can be realized and are cost effective an evaluation method should be developed which quantifies increases in productivity. The purpose of this thesis is to present an evaluation method which provides ostensive and confirmable evidence with regard to productivity changes and the cost/benefit of office automation. The Naval Laboratories Technical Office Automation and

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Office Automation Cost/Benefit Evaluation: A Methodology

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ABSTRACT

Office automation has been credited as a means by which office and organizational productivity can be increased. Incorporation of office automation technology can represent a large investment for any organization. To guarantee the proper allocation of resources, government managers and executives must utilize evaluation techniques which insure that the benefits of a program outweigh the costs. Naval Laboratories have been planning to purchase office automation technology to increase their productivity. To insure that the benefits of office automation can be realized and are cost effective an evaluation method should be developed which quantifies increases in productivity. The purpose of this thesis is to present an evaluation method which provides ostensive and confirmable evidence with regard to productivity changes and the cost/benefit of office automation. The Naval Laboratories Technical Office Automation and Communications System (NALTOACS) Pilot Assessment and the Automated Technical Information Processing System (ATIPS) at Naval Weapons Center (NWC) China Lake, California were used as the basis of analysis for the development of the evaluation method.

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I. INTRODUCTION

The goal of this thesis is to present a method for determining whether office automation (OA) increases productivity in Naval Laboratories and whether OA is cost effective for those laboratories. To this end the Naval Laboratories Technical Office Automation and Communications System (NALTOACS) Pilot Assessment and the office automation pilot system at Naval Weapons Center, China Lake, California have been analyzed. An overview of the major issues of this thesis is contained in this chapter.

This study addresses three major issues: productivity, the costs and benefits (cost/benefit) of office automation, and the methodology used to determine productivity and its cost/benefit. The first issue, productivity, is a measure of efficiency and effectiveness (Greenwood, 1984). Efficiency involves comparing inputs to outputs: how much or how little input is required for acceptable output or conversely how much output is acceptable given a fixed level of inputs. Effectiveness involves attainment of goals: for example, how a program or system affected profits if profits were the organizational goal. The second issue, cost/benefit, is addressed by comparing the overall benefit attained from the system with the overall cost. This is accomplished after a measure of office productivity has been determined. The third issue, the methodology used to determine productivity and cost/benefit, is addressed through analysis of the methodology used by

communications, computerized branch exchanges, and data base management systems (Levine, 1985).

B. POTENTIAL BENEFITS OF OFFICE AUTOMATION

Computer technology was initially sought by industry as a means of cutting secretarial and clerical costs. Office employment is estimated to be 30% of the total labor force (Panko, 1985). Greenwood (1984) estimated that 35% of the office labor force is involved in secretarial or clerical work. Given these estimates, secretarial/clerical work is estimated to comprise approximately 10% of the total labor effort in the workplace. Office automation has clearly proven that it can increase secretarial efficiency through the use of word processing equipment. Law and Pereira (1976) have shown through experimentation that the average secretary can only type ten words per minute when errors and disturbances were factored in. In their experiments, word processing equipment use was judged responsible for secretaries increasing their output to thirty words per minute: a 300% increase in output. Additionally, Shiff (1974) proposed that implementation of computerized office equipment could eventually eliminate typing, transcription, and filing from office work: thus eventually eliminating the secretary, too.

Apart from the reduction in secretarial help, Gottheimer (1979) suggests that automation of the office would significantly reduce the need for middle managers. This can be done by making executives more efficient. Macfarlane (1983) sights several aspects of OA systems that are important to management productivity. Information retrieval can save executives time by allowing them to access personal and corporate

information from their desk. Analytical tools such as spreadsheets can be used to analyze information once it has been retrieved. Special applications programs such as graphics allow presentation of information in a manner that makes reports more persuasive. Electronic mail allows information exchange in a faster and more informal fashion than normal mail which leads to a greater exchange of ideas and information.

In addition to increasing efficiency, OA can have other tangible and intangible benefits. Williams and Jones (1984) list the following as tangible benefits:

- equipment charges eliminated
- temporary help not needed
- overtime reductions
- work force reductions

They also list the following as intangible benefits:

- improved communications
- enhanced document appearance
- less time to prepare proposals and reports

Additionally, the Honeywell Technalysis Office Management Systems Division conducted a national survey in 1985 to examine the attitudes of office workers who have access to OA equipment. That survey revealed that 90% of those surveyed reported that due to OA they had more time to devote to creative activities. Those surveyed also reported that OA played a major role in helping them make better and more informed decisions. About half of those surveyed stated that OA equipment is responsible for increases in speed, efficiency, and productivity.

OA has been identified as a means for organizations to increase their productivity while decreasing their costs (Forest, 1979; Gottheimer, 1979; Williams and Jones, 1984).

C. IS OFFICE AUTOMATION REALLY BENEFICIAL?

There is a fear throughout industry that the potential benefits extolled by OA champions will not be realized. The installation of new technology per se is not the way to make offices more efficient and productive, according to Charles Callahan (EDP, 1985). Callahan contends that office automation cannot be justified by the vague claim that OA will "increase productivity" (p. 4); "management wants bottom line payoffs" (p. 4). Ralph Kleim (1985) wrote that using OA systems does not necessarily mean a bona fide increase in productivity.

Kathleen Foley Curley (1984) summerizes the skepticism about office automation.

> A real fear, particularly among line managers, is that new office automation technologies "may make us the best informed, unprofitable company in our market." How much information is too much? What are the benefits to be gained and how can they be quantified? There is also a question of whether an investment in office automation technology is appropriate in every business or in every industry. (p. 37)

The notion that OA may not be appropriate for every business or in every industry leads to the following question: how can a business or industry determine whether OA is appropriate for their needs? Specifically for this thesis, how can Naval Laboratories determine whether possible OA benefits will be realized?

D. OFFICE AUTOMATION AND NAVAL LABORATORIES

The Navy currently has eight laboratories that perform a wide variety of research functions. The goal of these laboratories is the development of new or improved equipment and/or techniques to support of the missions of the Department of Defense.

As early as 1979 then Secretary of the Navy (SecNav), W. Graham Claytor, Jr., stated in a memorandum to the Chief of Naval Operations

that administrative modernization in the Department of the Navy was required to cope with "the volume of correspondence and administrative material" (SecNav, July 1979). In 1982 the Naval Laboratories Technical Office Automation and Communications System (NALTOACS) program was established to coordinate the introduction of office systems technology into Naval laboratories as a means of enhancing productivity (NALTOACS, 1983). Previous to the establishment of NALTOACS, three of the eight Naval Laboratories had introduced OA technology. They are:

- David W. Taylor Naval Ship Research and Development Center (NSRDC), Bethesda, Maryland
- Naval Surface Weapons Center (NSWC) Dahlgren, Virginia
- Naval Weapons Center (NWC) China Lake, California

David W. Taylor NSRDC was assigned as the lead laboratory and was given the responsibility for NALTOACS. The Deputy Under Secretary of the Navy for Financial Management reaffirmed a requirement from the Commander, Naval Data Automation Command that an assessment of the OA pilot projects already in place should be performed prior to the initiation of any further OA implementation in Navy Laboratories. The pilot assessment done by David W. Taylor NSRDC was completed without gathering any quantitative evidence (i.e., reduction in personnel costs or travel costs) relating to productivity in an automated office. The study drew inferences of productivity changes by gathering subjective information (i.e., user opinions and estimates of how much time per day the OA system saved them) from laboratory OA users. The

objectivity is the ability to evaluate without the influence of personal feelings (House, 1980). Evaluation subjectivity is evaluation by personal feelings. Objective measures are distinguished from subjective measures by the presence or absence of ostensive indicators (Guttentag and Struening, 1972). Ostensive indicators are hard data: data that is external to an evaluator/observer, data that can be specified and measured using some agreed upon measurement tools. Patton (1978) writes:

> Qualitative methodology and a responsive, illuminative approach to evaluation most frequently stimulate charges of subjectivity - a label regarded as the very antithesis of scientific inquiry. Objectivity is considered the sine qua non of the scientific method. To be subjective means to be biased, unreliable, and nonrational. Subjective data implies opinion rather than fact, intuition rather than logic, impression rather than confirmation. Scientists are to eschew subjectivity and make their work "objective and value free". (p. 216)

This quotation from Patton should not be construed that opinion, intuition, and impression are mutually exclusive of fact and logic. The key point is that opinion, intuition, and impression are not confirmable. Evaluations should seek evidence that is ostensive and confirmable.

Which of these two methodologies should be chosen to evaluate a program? Patton (1978) wrote that different kinds of problems require different types of research methodology. NALTOACS "was established to coordinate the introduction of office systems technology into the Naval Laboratory as a means to enhance productivity." (NALTOACS, 1983, p. 1) The objectives for the NALTOACS Pilot Assessment, were to gather information relating to OA system planning, implementation, and benefits analysis (NALTOACS, 1983). The first two objectives,

gathering planning and implementation information, are questions of understanding; these objectives can best be attained through use of the qualitative methodology (Patton, 1979). The last objective, the benefits analysis, is a question of predicting performance. This is the most important objective of the Pilot Assessment because it determines whether the project is worthwhile: no matter how well planned or implemented a system is the bottom line is cost/benefit; if the benefits do not exceed the costs then the system is not worth planning or implementing. To perform a cost/benefit analysis the quantitative methodology should be employed; it is the method that results in a true bottom line of dollars and cents and it is the method that provides confirmable results.

The Pilot Assessment of the Naval Laboratories that had pilot office automation systems in place was an evaluation using the qualitative methodology. Appendix A contains a sample of the questionnaires and interview sheets used by NALTOACS to perform their evaluation. These questionnaires clearly sought the opinions and the perceptions of the system's users and managers. This thesis does not take issue with the selection of this methodology to gather information about OA system planning and implementation. However, this methodology is inadequate to perform a cost/benefit analysis because it does not return ostensive data. Also, there are biases inherent in the tools of the qualitative methodology, questionnaires and interviews, that cause the results evaluations using this methodology to be suspect. These biases are discussed in the next section.

E. QUALITATIVE METHODOLOGY SOURCES OF INVALIDITY IN THE NALTOACS PILOT ASSESSMENT

To this point information has been presented about the identity, purpose, and usefulness of evaluations in general. Also, the two basic types of evaluations have been presented with their perspective strengths and weaknesses with an argument why the quantitative methodology is preferable to the qualitative methodology for the performance of a benefits analysis. It has been established that the Pilot Assessment conducted by NALTOACS used the qualitative methodology: the questionnaires and personal interviews are subjective in nature (see Appendix A); this method invited opinion, intuition, and impression which is difficult if not impossible to confirm as fact. This section addresses the biases and sources of invalidity that result from surveys and questionnaires themselves. The NALTOACS Pilot Assessment is sited to exemplify the biases that explained in this section.

Webb et al. (1966) list three broad sources of bias and invalidity when the qualitative methodology is used:

1. errors that may be traced to those being studied,
2. errors that come from the investigator,
3. errors associated with sampling imperfections.

It is beyond the scope of this thesis to address the latter two sources of evaluation invalidity. However, errors that may be traced to those being studied, called the reactive measurement effect by Webb et al. (1966), are discussed in detail.

> The most understated risk to valid interpretation is the error produced by the respondent. Even when he is well intentioned and cooperative, the research subject's knowledge that he is participating in a scholarly search may confound the investigator's data. Four

> classes of this type of error are: awareness of being tested, role selection, measurement as a change agent, and response sets. (p. 13)

Of the four of reactive measurement effect errors listed above, only awareness of being tested, role selection, and response sets are applicable to this thesis; they are discussed below.

1. The Awareness of Being Tested

The awareness of being tested has been called the "reactive effect of measurement" bias by Campbell (1957). Selltiz et al. (1959) wrote:

> If people feel that they are "guinea pigs" being experimented with, or if they are being "tested" and must make a good impression, or if the method of data collection suggests responses or stimulates an interest the subject did not previously feel, the measuring process may distort the experimental results. (p. 97)

This does not mean that all subjects that are aware that they are part of a test will give inaccurate responses. However, the probability of bias is high in any study in which a respondent is aware that he is the subject of a test (Webb et al., 1976).

The subjects in the NALTOACS Pilot Assessment were definitely aware that they were part of an experiment. The "NALTOACS PILOT ASSESSMENT USER INTERVIEW CHECKLIST PACKAGE" (see Appendix A) contains the following instructions:

> The data being collected by this survey is required to conduct the "Pilot Assessment" directed by the Deputy Under Secretary of the Navy (Financial Management) and the Commander, Naval Data Automation Command.
>
> Please take this opportunity to candidly express your opinions and needs so that the overall planning for office automation (OA) in the Naval Laboratories can directly benefit from them. Also, please feel free to add any inputs which you may have and which are not covered by the checklist.

These instructions could influence the subject to give responses so that they make a "good impression" as described above by Selltiz. There are at least two reasons for this. First, the survey has been directed by the Deputy Under Secretary of the Navy who is in authority far above the respondents in the chain of command. This, coupled with the questionnaire requirement for respondents to sign the survey may have resulted in an unwillingness by the respondents to give responses that would "create waves". The second reason is related to the first in that the collector of the survey is from Washington and is, in some sense, in authority over the installation where the respondents work and the OA equipment is installed. There might be a tendency to give positive responses to avoid "telling on oneself" as an organization and incurring scrutiny from above.

2. Role Selection

Role selection is another way that a respondents awareness of research may produce bias. This bias may not be a defensive reaction or dishonesty but rather a specialized selection of a "proper behavior" by the respondent (Webb et al., 1976). The contention by Webb et al. here is that a person who is singled out by an experimenter forces the subject into a role defining decision, a decision as to what type of person should the respondent be to answer the questions.

The "NALTOACS PILOT ASSESSMENT USER CHECKLIST PACKAGE" (see Appendix A) gives the respondent an opportunity to select a role even before the respondent takes the survey. After the instructions a "user profile" section asks the respondent for the following information:

USER PROFILE Date:_____

Name:_____ Code:_____

Telephone:_____ Bldg:_____

How would you classify your job responsibilities:

Command and Support	Technical
___ Executive	___ Manager
___ Manager	___ Scientist
___ Supervisor	___ Systems Engineer
___ Professional	___ Programmer/Analyst
___ Clerical	___ Other _____
___ Other_____	_____

The implication of this is that the respondents could "play a role", as suggested by Webb et al., and answer questions not as they personally feel but as they feel an executive, a manager, or a professional should answer the questions.

3. Response Sets

Response sets deal with the way that questions are asked. For example, Sletto's experimentation led to his assertion that respondents will endorse a statement more frequently than they will disagree with its opposite (1937). Campbell wrote that the direction of wording can definitely influence the respondents in questionnaires and interviews (1965). Webb et al. demonstrated that respondents generally have a preference for strong statements rather than moderate or indecisive statements (1966). They also demonstrated that sequences of questions asked in a very similar format produced stereotyped answers, such as a tendency to select a righthand or lefthand response. Further, they proposed that decreasing attention produces biases from the order of presentation.

The NALTOACS PILOT ASSESSMENT USER INTERVIEW CHECKLIST PACKAGE (see Appendix A) has questions that could cause response set errors.

There are questions that ask the respondent to choose an answer from among a list of applicable answers. However, 74% of the first answers listed were responses that were positive for office automation in general (see Appendix A, p. 68). For example:

10. Please check the appropriate responses:

CALENDAR

___ Essential	___ Available	___ Use frequently
___ Nice to have	___ Not available	___ Use occationally
___ Do not need	___ Do not know if available	___ Do not use

I have___/have not___ been trained on this capability and I would classify the capability as:

___ Adequate to my needs	___ Easy to use
___ Must be improved, how so_____ _____	___ Difficult to use, how so_____ _____

"Essential", "Available", "Use frequently", "Adequate to my needs", and "Easy to use" all possess a positive connotation while "Do not need", "Do not know if available", "Do not use", "Must be improved", and "Difficult to use" all possess a negative connotation. There are five pages of questions similar to the one above covering the various capabilities of the pilot office automation systems.

11. How do you rate the overall responsiveness of the system in operation?

___ Fast (under 2 sec)	___ Slow (5-10 sec)
___ Adequate (2-4 sec)	___ Too slow (10 sec +)

17. In what way has the system assisted you in the preparation of products?

___ Get the job done with less effort, how much so? __%
___ Better quality of end products, how so?
- ___ Fewer typos
- ___ Better appearance
- ___ More timely

___ Other (specify) _____

Seventy percent of the questionnaire consisted of questions that were also asked in a similar format. The questionnaire was twenty pages long; fourteen of these pages (see Appendix A, questions 10 and 18) were similar in format. Due to the length and repetition of the question format it is possible that stereotyped answers were given as Webb et al. proposed above. The sheer length of this questionnaire brings into play the Webb et al. assertion that decreasing attention can produce biases.

F. SUMMARY

This chapter has examined the NALTOACS Pilot Assessment qualitative evaluation methodology. This methodology was determined to be appropriate, in principal, to fulfill the first two objectives (gathering information about OA system planning and implementation) of the NALTOACS Pilot Assessment. However, this methodology was considered inadequate to fulfill the most important objective, a cost/benefits analysis. There are two reasons why the qualitative methodology is inadequate for a cost/benefits analysis. First, results are based on opinions which are not ostensive and confirmable in nature. For example, the NALTOACS Pilot Assessment made quantitative estimates of productivity gains due to OA incorporation without performing any quantitative analysis; inferences were drawn from questionnaires and interviews - inferences of fact based on respondents' opinions. Specifically, the Pilot Assessment (NALTOACS 1983) estimates a productivity gain of 8 to 12% and a savings per year of 1,681 to 2,415 man-years across the seven Naval Laboratories (p. 49). This thesis does not contend the figures that NALTOACS presents

as inaccurate per se. However, there is no ostensive data here nor a method of confirmation. Thus, the conclusions drawn are suspect.

The second reason that the qualitative methodology can result in erroneous evaluation conclusions is that the tools of this methodology (questionnaires and interviews) can, in and of themselves, bias the respondents. Thus, even if the methodological approach was appropriate to perform a benefits analysis the results would still be suspect due to these errors and biases.

III. PROPOSED OA BENEFITS ANALYSIS METHOD

Chapter II critically analyzes the NALTOACS Pilot Assessment method. It begins with a discussion of evaluations in general, explains the strengths and weaknesses of the two main types of evaluation methodologies, and discusses evaluation objectivity and subjectivity. Then the NALTOACS Pilot Assessment methodology is examined; its inadequacy to attain its most important objective (an OA benefits analysis) is specifically addressed.

This chapter proposes a detailed method through which an OA benefits analysis can be performed. This is done by studying the ATIPS program located at Naval Weapons Center China Lake, California.

As previously stated in Chapter II, the corner stone of the quantitative methodology is the scientific method. The scientific method dictates that quantitative measurement and comparative analysis is the essence of reliable and valid evaluation (Patton, 1978). Measurement is the key, without it there can be no comparative analysis. The first task in tailoring the quantitative evaluation method into a specific application must be to select a measurement method that is consistent with the objectives of the evaluation. The evaluation objective that is the focus of this chapter is an OA cost/benefit analysis. Therefore, a method to measure the costs and benefits of an OA system must be devised.

Prior to the installation of any program or system there should be perceived need for that program/system. This will be the starting

point for the OA system performance measurement criteria. Wholey wrote that an evaluation of any program or system must document the extent to which management has defined the measures of resource inputs, program activities, outcomes, and impacts (1979).

> There are two parts to the question of measurability: (1) the indicator of achievement and (2) the means of verification. It is a standard part of program evaluation methodology that both indicators and means of verification be developed as part of any evaluation. (Schmidt et al., 1977)

The implication of these statements is that performance measurement can and should be done using management criteria as a basis for evaluation. This type of approach to program evaluation is known as "goal achievement" (Franklin and Thrasher, 1976). The advantages to the goal achievement approach is that it allows the implementor to be the control for the study and it insures that the evaluation is measurable and relevant to the implementor's original problems (Franklin and Thrasher, 1976). This approach is particularly useful in the evaluation of innovative programs (Rossi and Freeman, 1982). Office automation systems in Naval Laboratories, specifically the ATIPS system, are innovative. Therefore, this thesis uses the goal achievement approach in its measurement of the performance of the ATIPS program at NWC China Lake.

Rossi and Freeman (1982) write that the evaluation of an innovative program should include:

1. Identifying and describing the problem of concern,
2. Identifying the program and delineating the objectives developed to solve the problem,
3. Designing an impact model,
4. Designing an evidence gathering technique.

This chapter follows this basic outline. The outline contains terms and concepts that may not be intuitively obvious; these terms and the concepts in each step are explained as they are addressed.

A. PROBLEM IDENTIFICATION AND DESCRIPTION

The following paragraph is taken from the ATIPS Concept Development Paper (NWC, March 1982):

> The Naval Weapons Center (NWC), China Lake, faces heavily increasing administrative workloads along with reductions in the manpower currently handling those workloads. NWC personnel work in an almost exclusively manual administrative environment. What is needed is a more efficient methodology for handling the necessary administrative tasks of Center personnel. (p. 1)

An Inspector General's inspection of NWC in March 1980 reported that manpower ceilings had resulted in an increase in personnel workload and a decrease in the quality of work (NWC, July 1980). Through the 1970s the workforce at NWC had been reduced twenty percent due to billet restrictions while the total budget and workload had increased twenty percent (NWC, July 1980).

The problem that faced management at NWC China Lake was how to do more work with less people without negatively effecting the quality of the end product.

B. PROGRAM AND OBJECTIVES

In response to the problems listed above, four alternative courses of action were investigated; the alternative that promised the highest return on investment in the shortest period of time was the coordinated development of an Automated Technical Information Processing System (ATIPS) (NWC, August 1981). As discussed previously, ATIPS is an office automation system that uses a central computer and

remote access terminals to provide a variety of functions to the users. Among these functions are (NALTOACS, 1983):

word processing	electronic mail
document processing	electronic calendar
business graphics	form processing

The objectives of ATIPS were delineated in the Concept Development Paper (NWC, August 1981). These objectives are listed below:

1. Reduce administrative workload for technical and administrative personnel.
2. Reduce the amount of space required to store information.
3. Reduce the costs for typing, copying, transmitting, filing, and retrieving information.
4. Reduce the number and size of meetings.
5. Reduce the labor cost for each productive unit of work.
6. Make NWC a more cost-effective Research, Development, Test, and Evaluation Center.
7. Provide access to other NWC computers through a single terminal.
8. Provide a direct communication route among all personnel who require it.
9. Provide ready access to large quantities of textual information.

Another objective of the system (Objective 10) that was not communicated in the Concept Development Paper but was communicated to the author by the functional manager involved the quality of the deliverables that the Center produced; ATIPS was to increase the quality of the reports, manuals, briefings, and documents that the Center produced.

Greenwood's (1984) contention that productivity is a measure of efficiency and effectiveness can be applied to the stated ATIPS objectives. Efficiency is the comparison of inputs to outputs; the fewer inputs per unit of output (or the greater output per unit of

input) identifies an increase in efficiency. The first seven objectives listed for ATIPS are questions of efficiency; each of these objectives seeks to maximize outputs while minimizing inputs. The last three objectives are not concerned directly with efficiency (although that may be a side effect), rather these objectives are questions of effectiveness, of how well each worker and the Center can achieve its overall goal.

The basic objective of ATIPS can be reduced to: increasing personal and Center productivity through increasing both efficiency and effectiveness.

C. IMPACT MODEL

An impact model, which is similar to a logical model (Wholey, 1979), is an attempt to translate notions regarding the modifications and controls of a condition into a hypotheses on which action can be based (Rossi and Freeman, 1982). There are two hypotheses that should be addressed:

1. the causal hypothesis,
2. the intervention hypothesis (Rossi and Freeman, 1982).

The causal hypothesis is a hypothesis about the influence of one or more processes on the condition that the program seeks to modify. It is the relationship between the program or system inputs, activities, and outcomes (Wholey, 1979). For NWC China Lake the causal hypothesis is: The availability of only manual administrative tools coupled with an increasing workload and a decreasing workforce is responsible for lower productivity at NWC China Lake.

Using this causal hypothesis as a base, the remainder of the impact model can be developed through the intervention hypothesis

(Rossi and Freeman, 1982). The intervention hypothesis is a statement that specifies the relationship between a program, what is going to be done, and the causal hypothesis. In the case of NWC China Lake there are three variables (manual administrative tools, increasing workload, and decreasing work force) in the causal hypothesis that influence the outcome (productivity). The only means by which to change the outcome is by changing one of the three variables. However, it was not possible for the Center to hire more workers or to refuse projects and lighten its workload. Therefore, the first two variables are constants. The only variable in which change was feasible was the use of manual administrative tools. ATIPS was purchased to replace manual administrative tools with automated tools. The goal was to increase worker productivity. Therefore, the intervention hypothesis is: Office automation technology increases overall productivity at NWC China Lake.

The impact or logical model provides a clear view of the relationships between the initial conditions and problems, the intervening program, and the outcomes.

D. EVIDENCE GATHERING/MEASUREMENT MODEL

The evidence gathering technique that is used in an evaluation is influenced by the basic evaluation methodology and the evaluative approach. The basic evaluation methodology that this proposed OA cost/benefits analysis method uses is the quantitative method described in chapter two. The evaluative approach that this proposed OA cost/benefits analysis method uses is the goal achievement approach described earlier in this chapter. The implication of using the

quantitative methodology and the goal achievement approach is that the evidence gathering technique should yield ostensive data for comparative analysis by utilizing the program's objectives and the program management's projected performance measurement criteria. Therefore, the project ATIPS performance criteria and the program's objectives are examined prior to the selection of an evidence gathering technique. Once the evidence gathering technique is determined the measures of program performance are refined from the projected program performance criteria and the program's objectives. Following that refinement evidence gathering technique can be implemented.

1. Projected ATIPS Performance

NWC contracted The Mattox Group, a consulting firm in Pasadena, California, to study a portion of the workers at the Center for the purpose of identifying potential opportunities to increase the efficiency and effectiveness of the Center's managerial, technical, and support personnel (Mattox, February 1981). The study consisted of three parts. First, a "shadowing" was conducted of each member of a pilot group for 8 to 16 hours. Second, 250 representatives from all departments were interviewed. Third, interview data was correlated with the "shadow" data (see Appendix B for Mattox Group evaluation data). The Mattox Group study concluded that an office automation system at the Center could have a tremendous impact and potentially save managers, technical and support staff 20% of their time.

The ATIPS project development group used this 20% figure as a basis to project the potential personnel salary/wage cost avoidance savings that could be expected throughout the life of ATIPS (see

Appendix B for the figures and calculations). The analysis indicated that ATIPS would result in a $5.7 M personnel cost avoidance in its first year of operation. This figure would increase as ATIPS grew to its full size and the life cycle cost avoidance for personnel could reach $151 M (NWC, August 1981).

The second area of quantitative measurement criteria involves travel. The Mattox Group estimated that a 15% reduction in travel requirements would be possible through the use of ATIPS communication capabilities (Mattox, February 1981). NWC personnel were averaging 7000 off Center trips per year at an average cost of $1,200 per trip (NWC, August 1981). This meant that ATIPS could save $420 K in its first year of operation and $8.82 M over its life-cycle (see Appendix B). In addition to the reduction in the cost of travel the personnel cost avoidance that resulted from the decreased travel time was calculated. This would result in a $70 K cost avoidance in the first year of ATIPS operation and a $1.4 M cost avoidance over the life-cycle (NWC, August 1981) (see Appendix B).

The project group also estimated that 50% of the Center's costs for maintenance of office equipment would be avoided due to less wear and decreased usage of copiers, typewriters, and other office equipment. This would result in a $200 K savings the first year of ATIPS operation and a $4.2 M savings over the life-cycle of the system (NWC, August 1981) (see Appendix B).

2. ATIPS Program Objectives

The goal achievement method of performance measurement requires that the evidence gathering technique for a program be based upon the management's measurement criteria and the program's

objectives and goals (Franklin and Thrasher, 1976). As presented previously, the ATIPS program objectives are:

1. Reduce administrative workload for technical and administrative personnel.
2. Reduce the costs for typing, copying, transmitting, filing, and retrieving information.
3. Reduce the labor cost for each productive unit of work.
4. Reduce the number and size of meetings.
5. Reduce the amount of space required to store information.
6. Provide access to other NWC computers through a single terminal.
7. Provide a direct communication route among all personnel who require it.
8. Provide ready access to large quantities of textual information.
9. Increase the quality of the deliverables produced by the Center.
10. Make NWC a more cost-effective Research, Development, Test, and Evaluation Center.

3. Evaluation Technique Selection

The projected ATIPS performance criteria and the ATIPS program objectives are similar in that they both suggest that the introduction of ATIPS will result in either reductions or increases of costs, workloads, cost-effectiveness, and quantities of textual information, for example. This suggests that measurements made before the introduction of ATIPS could be compared to measurements made after the introduction of ATIPS; this comparison would result in indication of benefits realized/not realized due to the introduction of ATIPS. This type of evidence gathering technique is known as a quasi-experimental time series design (Franklin and Thrasher, 1976). Wholey (1979) describes the quasi-experimental time series design of evidence gathering.

> . . . the evaluator measures outcome variables several times before, and several times after, participants are exposed to the program. Program effectiveness is estimated by comparing the post-program measurements with the pre-program measurements. The evaluator plots the time series data; then the evaluator and other knowledgeable people examine the data, consider possible alternative explanations for the observed results, and attempt to draw conclusions about the effectiveness of the program. (p. 160)

This evidence gathering technique fits the with the projected ATIPS performance criteria and the objectives listed for the ATIPS program. The quasi-experimental time series design is the evidence gathering technique that this proposed evaluation method uses.

4. Refinement of Program Performance Measures

Goal achievement is the evaluative approach used for the OA benefits evaluation method proposed by this thesis. As stated earlier, the goal achievement approach requires that the program objectives and the projected program performance measures be used as the basis for the evaluation. This means that the selection of specific performance measures should involve the program's objectives and projected performance measures.

The ATIPS program objectives are listed on page 9 of this chapter. These 10 objectives can be combined into five groups of objectives:

1. Reduce the cost of administration by reducing the workload and reducing the cost per unit of output.
2. Allow access through computer terminals to multiple computers, large text libraries, and other personnel.
3. Reduce the number of meetings.
4. Reduce storage space needed for information.
5. Increase the quality of the work produced.

The ATIPS program's projected performance criteria are explained on pages 7 and 8 of this chapter. These performance criteria list three areas of performance measurement:

1. personnel cost avoidance,

2. reduction of meetings requiring travel away from NWC China Lake,

3. reduction in the cost of maintenance on office equipment.

How do the objectives relate to the performance measurement criteria established by management prior to the introduction of ATIPS? There appears to be only one direct relationship, that is between the objective to reduce meetings and the projected performance criteria to reduce travel due to meetings. However, this projected performance measurement does not include meetings that are held at NWC China Lake.

The cost avoidance performance measurement is only loosely related to the objectives of cost reduction of administration and reduction of the number of meetings. Cost avoidance as a performance measure does not lend itself to true measurement after the ATIPS program is in place. This is in contrast to the other two projected performance criteria which do lend themselves to measurement. Therefore, the author views cost avoidance as more of a goal of the ATIPS system rather than a performance measure for the program's stated goals.

The question remaining is what types of measures of performance should be used to provide evidence about the benefits obtained from the incorporation of the ATIPS system? This thesis can only offer suggestions as to the appropriate measures of performance because to select these measures requires the involvement of the management (Rossi and Freeman, 1982). Wholey (1979) wrote:

> The key to useful performance monitoring is agreement between the evaluator and the intended user on the events to be monitored, the measures to be used in the monitoring, and the intended uses of the resulting information. (p. 137)

This information leads the author of this thesis to suggest appropriate performance measures for each of the objectives of the ATIPS program. Each of the objective groupings on page 9 are addressed in order.

To measure the effect of ATIPS on the volume of paperwork at NWC (Objective 1) paper itself should be measured. A comparison of paper usage should yield a reduction in usage after ATIPS was introduced. This measure should be weighted to account for the differences in project load that NWC experiences during the measurement periods.

To measure the the effect of ATIPS on the cost of administrative work (Objectives 2 and 3) a comparison of administrative output and cost should be made. Administrative output is not synonymous with total paper usage. Output is the sum of all the manuals, reports, briefings, presentations, letters, and the like that NWC China Lake produces during a period of time. Cost is the total equipment maintenance and labor costs during the same period of time. Labor costs are particularly difficult to measure because of the concept of cost avoidance. It is unlikely that there will be any savings in personnel labor costs per se. However, the concept of cost avoidance implies that personnel will complete tasks in a more timely fashion. The implication of this statement is that personnel should be able to perform more tasks in the same unit of time. Therefore, since NWC is not expected to reduce its work force, to detect a change in labor cost per unit of work will require measuring workload and staff size: the output should go up while the labor force remains constant.

To measure the effect that ATIPS has on the number and the size of meetings (Objective 4) the number of off station trips made due to meetings can be measured and compared (as suggested by the projected performance measurement criteria). Also, historical records could be used to determine the number of on station meetings required before ATIPS; the number of meeting required since the installation of ATIPS could be measured and a comparison made.

A measure of the amount of space required to store information (Objective 5) could involve researching supply records to obtain information concerning the purchase of storage units before and after the incorporation of ATIPS.

Measurement of the access to other computers through ATIPS terminals, measurement of communications capabilities, and the amount of textual information available through an ATIPS terminal (Objectives 6-8) can all be measured directly without research.

Measurement of the quality of the deliverables produced by the center (Objective 9) before and after ATIPS could be done by direct comparison. Copies of deliverables produced before ATIPS incorporation could be compared with deliverables that are similar in nature but produced after ATIPS incorporation. The judges of the quality of the deliverables could be a composite team of professionals from both outside and within NWC China Lake. Stufflebeam et al. (1974) wrote that professional judgement is an effective evaluation tool when measurement criteria are difficult to define and quantify. Professional judgement is based on the evaluators experience and expertise. The criteria of the quality measurement should be agreed

upon by the professionals prior to the actual performance of the evaluation.

The final objective is an objective that encompasses all of the others and includes the purpose of this proposed evaluation method: making NWC more cost effective. Measurement of the other objectives will provide evidence for this objective. This is where the issue of cost/benefit is resolved. The measures described above produce figures of relative savings. These relative savings should be totaled and compared to the cost of the system. If the savings total is greater than the cost of the system then the system is worth purchasing; it is worth purchasing for all the Naval Laboratories.

E. SUMMARY

This chapter describes an method of evaluating the impact of office automation technology in Naval Laboratories. The Naval Weapons Center China Lake, California is the subject for a case study; by utilizing information from NWC an evaluation method is presented using the qualitative methodology and the goal achievement evaluative approach. The goal of the evaluation method is to provide ostensive data for the performance of a cost/benefit analysis.

IV. SUMMARY AND RECOMMENDATIONS

This thesis presents a method for determining the productivity effects and the cost/benefit of office automation in Naval Laboratories. Formulation of this method included analysis of the NALTOACS Pilot Assessment and an analysis of the pilot office automation system (ATIPS) at NWC China Lake, California.

Chapter I presents a definition of office automation and provides evidence that organizations can realize both tangible and intangible benefits through the incorporation of OA technology. The primary benefit claimed for OA is increased productivity. However, a survey of current literature indicated skepticism over the realization of benefits due to OA. The chapter concludes with an overview of the NALTOACS Pilot Assessment and the ATIPS system at NWC China Lake.

Chapter II analyzes the NALTOACS Pilot Assessment method in detail. A qualitative method was used to perform the NALTOACS Pilot Assessment. The chapter provides evidence showing that this methodology was inappropriate for two reasons. First, the results of the qualitative evaluation are based on opinions which are not ostensive and confirmable in nature. Second, the qualitative methodology can produce erroneous results due to the biases inherent in this evaluative paradigm.

Chapter III presents a method of evaluating the impact of office automation in Naval Laboratories, a method based on a quantitative method. This evaluation method incorporates the goal-achievement-evaluative approach and uses the ATIPS system at NWC China Lake as a

subject of a case study. The goal of the evaluation method is to prcvide ostensive data for the performance of a cost/benefit analysis. The purpose of using the goal-achievement-evaluative approach is to insure that the goals, objectives, and performance criteria developed during project initiation are used in the project evaluation.

The ATIPS office automation program was estimated to cost nearly $12 million. Incorporation of OA systems at all eight Naval Laboratories could cost more than $100 million. One performance criterion for the investment of public funds is that the trustees of those funds maximize the return on the investment; this is responsibility of the position and demanded by the public (Franklin and Thrasher, 1976). To ensure that goal of maximizing return on investment is achieved, the implementation of evaluation techniques is required. These evaluation techniques should produce measurable and confirmable results.

The NALTOACS Pilot Assessment was a qualitative evaluation of office automation in Naval Laboratories. The evaluation results were a compilation of the opinions of the surveyed respondents; inferences about benefits and productivity gains due to OA were made based on those opinions. The actual productivity results were not measured nor confirmed nor did they appear to be measurable or confirmable. Hence, the NALTOACS Pilot Assessment does not provide information which is useful in determining the program's return on investment.

The evaluation method proposed by this thesis produces results that are both measurable and confirmable. Further, the data produced by the evaluation method insures that the objectives of the system are

considered in its evaluation and that the program's cost effectiveness is determined.

NALTOACS was established to coordinate the introduction of OA systems as means to enhance productivity in Naval Laboratories (NALTOACS, 1983). The recommendation of the author is to perform an evaluation of an operating Naval Laboratory OA system using the method described in this thesis. This will provide ostensive data which will indicate whether office automation does indeed enhance productivity and whether that enhancement is cost effective.

APPENDIX A

NALTOACS PILOT ASSESSMENT USER INTERVIEW CHECKLIST

NALTOACS PILOT ASSESSMENT

USER INTERVIEW CHECKLIST PACKAGE

The data being collected by this survey is required to conduct the "Pilot Assessment" directed by the Deputy Under Secretary of the Navy (Financial Management) and the Commander, Naval Data Automation Command.

Please take this opportunity to candidly express your opinions and needs so that the overall planning for office automation (OA) in the Naval laboratories can directly benefit from them. Also, please feel free to add any inputs which you may have and which are not covered by the checklist.

Thank you for your cooperation and assistance.

_____

Project Manager

USER PROFILE Date:_____

Name:_____ Code:_____

Telephone:_____ Bldg:_____

How would you classify your job responsibilities:

Command and Support	Technical
_____ Executive	
_____ Manager	_____ Manager
_____ Supervisor	_____ Scientist
_____ Professional	_____ Systems Engineer
_____ Clerical	_____ Programmer/Analyst
_____ Other _____	_____ Other _____
_____	_____

SURVEYOR_____ TELE #_____ NWC

1. Did you use other keyboard devices in your office before the pilot OA was implemented?

No__ Yes__

		Still use__	
Typewriter	___	Typewriter	___
Computer Terminal	___	Computer Terminal	___
WP Workstation	___	WP Workstation	___
Personal Computer	___	Personal Computer	___

2. Do you have a personal computer at home?

No__ Yes__

3. Do you have your own pilot OA workstation?

No__, how far away is the workstation you share? ____ ft.

Yes__, with

___ Dedicated Letter Quality Printer
___ Shared Letter Quality Printer How far away?____ ft.
___ Dedicated Dot Matrix Printer
___ Shared Dot Matrix Printer How far away?____ ft.
___ Shared Plotter How far away?____ ft.
___ Local Storage

4. Do you need your own dedicated OA workstation?

No__ Yes__

5. Do you or would you use it as a terminal for programming?

No__ Yes__

6. How long have you been an active user of the pilot OA system?

___ Less than 1 month ___ Over 6 months
___ Less than 3 months ___ Over 12 months
___ Less than 6 months ___ Over 18 months

7. Do you feel that you were adequately prepared/trained to use the OA system?
No__ Yes__ Did not attend training sessions__

8. Do you feel the system provides enough OA self-help features to enable you to use it with ease?

No__ Yes __, for frequently used capabilities
No__ Yes __, for infrequently used capabilities

9. Do you feel the pilot project staff provides adequate user assistance?

No__ Yes__

10. The following are general descriptions of the basic OA functional capabilities included in some pilot OA systems. After each is a series of questions pertaining to your knowledge, use and assessment of them. (Please check the appropriate response/responses.)

CALENDAR - Allows a user to maintain an appointment calendar, both public and private. It provides the functions for adding, changing, deleting, searching and viewing the entries.

___Essential	___Available	___Use frequently
___Nice to have	___Not available	___Use occasionally
___Do not need	___Do not know if available	___Do not use

I have___ /have not___ been trained on this capability and I would classify the capability as:

___Adequate to my needs	___Easy to use
___Must be improved, how so _____ _____	___Difficult to use, how so _____ _____

TICKLER Notifies the user on a given day and time that a certain action or task, previously entered by the user, needs to be performed that day.

___Essential	___Available	___Use frequently
___Nice to have	___Not available	___Use occasionally
___Do not need	___Do not know if available	___Do not use

I have___ /have not___ been trained on this capability and I would classify the capability as:

___Adequate to my needs	___Easy to use
___Must be improved, how so _____ _____	___Difficult to use, how so _____ _____

TELEPHONE - Provides the user with a standard telephone message pad for taking telephone messages for other users on the system. The message will be sent to the recipient electronically.

___Essential	___Available	___Use frequently
___Nice to have	___Not available	___Use occasionally
___Do not need	___Do not know if available	___Do not use

I have___ /have not___ been trained on this capability and I would classify the capability as:

___Adequate to my needs
___Must be improved, how so _____
_____

___Easy to use
___Difficult to use, how so _____
_____

DIRECTORY - Provides a convenient way for looking up the telephone numbers of associates that are frequently called.

___Essential
___Nice to have
___Do not need

___Available
___Not available
___Do not know if available

___Use frequently
___Use occasionally
___Do not use

I have___ /have not___ been trained on this capability and I would classify the capability as:

___Adequate to my needs
___Must be improved, how so _____
_____

___Easy to use
___Difficult to use, how so _____
_____

BULLETIN BOARD - Announces important events or information of general interest to all or a specified group of users. Announcements may refer to a longer explanatory record that can be retrieved by interested parties.

___Essential
___Nice to have
___Do not need

___Available
___Not available
___Do not know if available

___Use frequently
___Use occasionally
___Do not use

I have___ /have not___ been trained on this capability and I would classify the capability as:

___Adequate to my needs
___Must be improved, how so _____
_____

___Easy to use
___Difficult to use, how so _____
_____

ELECTRONIC MAIL - Replaces the inter-office memoranda and other informal correspondence. It allows the user to scan his mail box, to read mail, to reply to the mail, and to file and print mail.

___Essential
___Nice to have
___Do not need

___Available
___Not available
___Do not know if available

___Use frequently
___Use occasionally
___Do not use

I have___ /have not___ been trained on this capability and I would classify the capability as:

___Adequate to my needs
___Must be improved, how so _____
_____

___Easy to use
___Difficult to use, how so _____
_____

WORD PROCESSING - Provides a comprehensive input and editing capability that allows users to create, edit and manipulate text quickly and easily.

___Essential
___Nice to have
___Do not need

___Available
___Not available
___Do not know if available

___Use frequently
___Use occasionally
___Do not use

I have___ /have not___ been trained on this capability and I would classify the capability as:

___Adequate to my needs
___Must be improved, how so _____
_____

___Easy to use
___Difficult to use, how so _____
_____

FORM PROCESSING - Allows the user to retrieve a standard form, insert the information required and then store, print or forward the document. The user may also create special forms for one-time or repetitive use.

___Essential
___Nice to have
___Do not need

___Available
___Not available
___Do not know if available

___Use frequently
___Use occasionally
___Do not use

I have___ /have not___ been trained on this capability and I would classify the capability as:

___Adequate to my needs
___Must be improved, how so _____
_____

___Easy to use
___Difficult to use, how so _____
_____

DOCUMENT PROCESSING - Extension of the basic word processing system to permit the pulling together of text from various sources to create a large document in a consistent format.

___Essential
___Nice to have
___Do not need

___Available
___Not available
___Do not know if available

___Use frequently
___Use occasionally
___Do not use

SCHEDULER - Determines the earliest time that all specified attendees are available by checking their individual calendar records. Once all attendees have confirmed the date and time, the meeting will be scheduled and an entry will appear in each user's calendar.

___Essential ___Available ___Use frequently
___Nice to have ___Not available ___Use occasionally
___Do not need ___Do not know if available ___Do not use

I have___ /have not___ been trained on this capability and I would classify the capability as:

___Adequate to my needs ___Easy to use
___Must be improved, how so _____ ___Difficult to use, how so _____
_____ _____

11. How do you rate the overall responsiveness of the system in operation?

___Fast (under 2 sec) ___Slow (5-10 sec)
___Adequate (2-4 sec) ___Too Slow (10 sec or above)

12. In what OA capabilities has response time been the slowest (list slowest first)?

1._____ 3._____

2._____ 4._____

13. On the average, what percent of your day is spent using your OA workstation?

____ 0-5% (1/2 hour)
____ 6-12% (1 hour)
____ 13-25% (2 hours)
____ 26-37% (3 hours)
____ 38-50% (4 hours)
____ Over 50%

14. Which capabilities do you use the most?

1._____

2._____

3._____

4._____

15. Which capabilities would you use more extensively if there were more users on the system?

1._____
2._____
3._____
4._____

EXAMPLES: Electronic Mail, Scheduler, Bulletin Board, etc.

16. What specific functions or products do you use the system to complete?

1._____
2._____
3._____
4._____
5._____
6._____
7._____
8._____
9._____
10._____

EXAMPLES: Correspondence, Technical Reports, Specifications, Memoranda, Administrative Reports (by name), Statement of Work, Procurement Requests, etc.

17. In what way does the system assist you in the preparation of these products?

___Get the job done with less effort, how much so?___%

___Better quality of end product, how so?
- ___Fewer typos
- ___Better appearance
- ___More timely

___Other (Specify)_____

_____

_____

18. The following are general descriptions of additional OA functional capabilities that may be installed in the future on your OA system. Please check the appropriate response/responses.

CORRESPONDENCE CONTROL - Enables the tracking of formal correspondence as it moves from one addressee (location) to the next. It requires the posting of receipt and forwarded entries as it moves from one point to another.

___ Essential; would use frequently
___ Nice to have; would use occasionally
___ Do not need

If this capability is made available, specify which office products and their associated tasks would be accomplished more efficiently.

Products	Tasks
_____	_____
_____	_____
_____	_____
_____	_____

PHONEBOOK - Provides a central telephone directory-like listing available to all users which includes the name, telephone number, organizational code, and office location of all on-base personnel.

___ Essential; would use frequently
___ Nice to have; would use occasionally
___ Do not need

If this capability is made available, specify which office products and their associated tasks would be accomplished more efficiently.

Products	Tasks
_____	_____
_____	_____
_____	_____

PERT - Allows a user to construct and maintain PERT networks, and do CPM analyses.

___ Essential; would use frequently
___ Nice to have; would use occasionally
___ Do not need

If this capability is made available, specify which office products and their associated tasks would be accomplished more efficiently.

Products	Tasks
_____	_____
_____	_____
_____	_____

INTERACT - Allows users to send and receive messages to each other in a dialogue fashion through their workstations.

___ Essential; would use frequently
___ Nice to have; would use occasionally
___ Do not need

If this capability is made available, specify which office products and their associated tasks would be accomplished more efficiently.

Products	Tasks
_____	_____
	_____
_____	_____
	_____
_____	_____
	_____
_____	_____

ROUTING - Allows an electronic document to be routed sequentially to other users according to an input specified or pre-established distribution list.

___ Essential; would use frequently
___ Nice to have; would use occasionally
___ Do not need

If this capability is made available, specify which office products and their associated tasks would be accomplished more efficiently.

Products	Tasks
_____	_____
	_____
_____	_____
	_____
_____	_____
	_____
_____	_____

INTERCONNECT - Allows the workstation to be linked to a computer system such that the workstation becomes a terminal on that system for programming, data retrieval, etc.

___ Essential; would use frequently
___ Nice to have; would use occasionally
___ Do not need

If this capability is made available, specify which office products and their associated tasks would be accomplished more efficiently.

Products	Tasks
_____	_____
	_____
_____	_____
	_____
_____	_____
	_____
_____	_____

SIGNATURE - Allows a user to "sign" a document electronically by typing in an alphanumeric string known only to himself/herself and the system.

___ Essential; would use frequently
___ Nice to have; would use occasionally
___ Do not need

If this capability is made available, specify which office products and their associated tasks would be accomplished more efficiently.

Products	Tasks
_____	_____
	_____
_____	_____
	_____
_____	_____
	_____
_____	_____

AUDIBLE MAIL - Allows the user to listen to a computer readout of his electronic mail, when the user is away from his/her workstation but has access to a touchtone telephone.

___ Essential; would use frequently
___ Nice to have; would use occasionally
___ Do not need

If this capability is made available, specify which office products and their associated tasks would be accomplished more efficiently.

Products	Tasks
_____	_____
_____	_____
_____	_____

VOICE MAIL - An audio version of electronic mail. Messages are input to the system by voice and recordings are retrieved by the addressees.

___ Essential; would use frequently
___ Nice to have; would use occasionally
___ Do not need

If this capability is made available, specify which office products and their associated tasks would be accomplished more efficiently.

Products	Tasks
_____	_____
_____	_____
_____	_____

TELECONFERENCING - A form of computer session where all attendees are simultaneously connected and communicate with each other in an interactive mode.

___ Essential; would use frequently
___ Nice to have; would use occasionally
___ Do not need

If this capability is made available, specify which office products and their associated tasks would be accomplished more efficiently.

Products	Tasks
_____	_____
_____	_____
_____	_____

STOPLIST - Points out all occurrences of words in the text which have been prohibited.

___ Essential; would use frequently
___ Nice to have; would use occasionally
___ Do not need

If this capability is made available, specify which office products and their associated tasks would be accomplished more efficiently.

Products	Tasks
_____	_____
_____	_____
_____	_____

ARCHIVE - Allows documents to be filed with user-specified filing codes, keywords, and indexes, such as subject, originator, file number, serial number and date. Users can retrieve a copy or restore the documents to active (and modifiable) status.

___ Essential; would use frequently
___ Nice to have; would use occasionally
___ Do not need

If this capability is made available, specify which office products and their associated tasks would be accomplished more efficiently.

Products	Tasks
_____	_____
	_____
_____	_____
	_____
_____	_____
	_____
_____	_____

FILE TRANSFER - Addresses and transfers stored text or data files from one computer storage system to another, or from one station (assuming local storage) to another, etc.

___ Essential; would use frequently
___ Nice to have; would use occasionally
___ Do not need

If this capability is made available, specify which office products and their associated tasks would be accomplished more efficiently.

Products	Tasks
_____	_____
	_____
_____	_____
	_____
_____	_____
	_____
_____	_____

ELECTRONIC SPREAD SHEET - Allows the user to construct columns and rows of numbers. Column and row totals are automatically corrected as individual members in the matrix are modified.

___ Essential; would use frequently
___ Nice to have; would use occasionally
___ Do not need

If this capability is made available, specify which office products and their associated tasks would be accomplished more efficiently.

Products	Tasks
_____	_____
	_____
_____	_____
	_____
_____	_____
	_____
_____	_____

DATA FILE - Allows the user to create, edit, maintain and retrieve data in a format (with edit criteria) as specified by the user.

___ Essential; would use frequently
___ Nice to have; would use occasionally
___ Do not need

If this capability is made available, specify which office products and their associated tasks would be accomplished more efficiently.

Products	Tasks
_____	_____
	_____
_____	_____
	_____
_____	_____
	_____
_____	_____

REPORT WRITER - Allows a user to subject a data file to elementary numeric manipulations and to retrieve the results in a report format specified by the user.

___ Essential; would use frequently
___ Nice to have; would use occasionally
___ Do not need

If this capability is made available, specify which office products and their associated tasks would be accomplished more efficiently.

Products	Tasks
_____	_____
	_____
_____	_____
	_____
_____	_____
	_____
_____	_____

INTERROGATE - Allows a user to display a record(s) meeting specified selection criteria from a data file specified by the user.

___ Essential; would use frequently
___ Nice to have; would use occasionally
___ Do not need

If this capability is made available, specify which office products and their associated tasks would be accomplished more efficiently.

Products	Tasks
_____	_____
	_____
_____	_____
	_____
_____	_____
	_____
_____	_____

19. To what level would you increase your usage of the system if it offered all the capabilities described above.

____ 0-5% (1/2 hour)
____ 6-12% (1 hour)
____ 13-25% (2 hours)
____ 26-37% (3 hours)
____ 38-50% (4 hours)
____ Over 50%

20. How would you rate the reliability of the hardware?

___ Excellent ___ Good ___ Satisfactory ___ Poor

21. What hardware devices have required the most maintenance?

____ CRT
____ Keyboard
____ Printer
____ Disc Drives
____ Telecom Interface or Telephone Lines
____ Other (Specify) _____
_____

22. If hardware failure occurs, how would you rate the response time for maintenance?

___ Adequate ___ Slow ___ Too Slow

23. Do you have a personal contact for questions and problems concerning OA software applications?

No___ Yes ___
In-house ___
Vendor ___

24. How often have you experienced software problems?

___ Rarely (Once every 3 months) ___ Often (Twice a month)
With what capability:
___ Occasionally (Once a month) _____

25. How would you rate the response time for software maintenance?

___ Adequate ___ Slow ___ Too Slow

26. How often does a system failure or crash occur?

___ Rarely (Once every 3 months) ___ Occasionally (Once a month) ___ Often (Twice a month)

27. Are there backup and recovery procedures in the event of system failures?

No ___ Yes ___

28. Do you have to repeat (or re-enter) work already done after a system failure or crash?

No ___ Yes___

29. Does the potential unreliability of the system inhibit you from using it for quick response or fast turn-around?

No ___ Yes ___

(Please comment)_____
_____
_____

30. Are you given satisfactory notification of scheduled downtime?

No ___ Yes ___

31. What are the most frequent reasons for the scheduled downtime?

Scheduled maintenance _____
Telecommunications _____
Software enhancements_____
Hardware modifications_____
Other (specify)_____
_____
_____
_____

32. Do you or would you like to use your workstation for non-OA functions?

No___ Yes___

____ Programming
____ Data retrieval
____ Other (Specify)_____

33. Do you by-pass the OA functions and use your workstation to directly interact with system software?

No _____ Yes _____ (If yes, why)

_____

_____

_____

34. To what level would you increase your <u>cumulative</u> usage of the system if your workstation accumulatively added these features:

	USAGE					
	06-12% (1 hr)	13-25% (2 hr)	26-37% (3 hr)	35-50% (4 hr)	51-62% (5 hr)	63-75% (6 hr)
WORKSTATION WITH:						
Intelligence						
Local Storage						
Local Plotter						
Engin. Graphics						
Voice						
488 Interface						

35. What do you like the most about your OA system?

_____

_____

_____

36. What do you like the least about your OA system?

_____

_____

_____

Data Collection Monitor:

Received _____

Reviewed _____

Tabulated_____

/s/_____

SUMMARY OF SURVEY QUESTIONS AND RESPONSES

This is a summary of the questions contained in the NALTOACS survey listed on pages 1 through 20. This summary examines each survey question to determine whether the responses in each question lists a response judged positive (by the author) for OA in general or negative/neutral for OA in general.

Question	
1 - 9:	negative/neutral
10:	Series of 13 OA systems functions the respondent is asked to judge. Each of the functions has six response areas; five of these areas list positive responses for OA first. Therefore, there are 65 positive and 13 negative/neutral
11:	positive
12 - 16:	negative/neutral
17:	positive
18:	Series of 17 additional OA functional capabilities that are available. Each function has one positive response. Therefore, there are 17 positive responses.
19:	negative/neutral
20:	positive
21:	negative/neutral
22:	positive
23:	negative/neutral
24 - 26:	positive
27:	negative/neutral
28 - 29:	positive

30 - 34: negative/neutral

35: positive

36: negative/neutral

The NALTOACS questionnaire provides the opportunity for 124 responses. Of that 124, 92 of the responses are judged by the author to be positive (in favor of OA in general) or the first response option listed is positive. The remaining 32 are considered negative or neutral of OA in general or the first response option listed is negative/neutral. Dividing the number of positive responses (92) by the total number of responses (124) yields a figure of 74%.

APPENDIX B

PROJECTIONS OF POTENTIAL SAVINGS THROUGH THE INCORPORATION OF OFFICE AUTOMATION EQUIPMENT AT NAVAL WEAPONS CENTER CHINA LAKE, CALIFORNIA

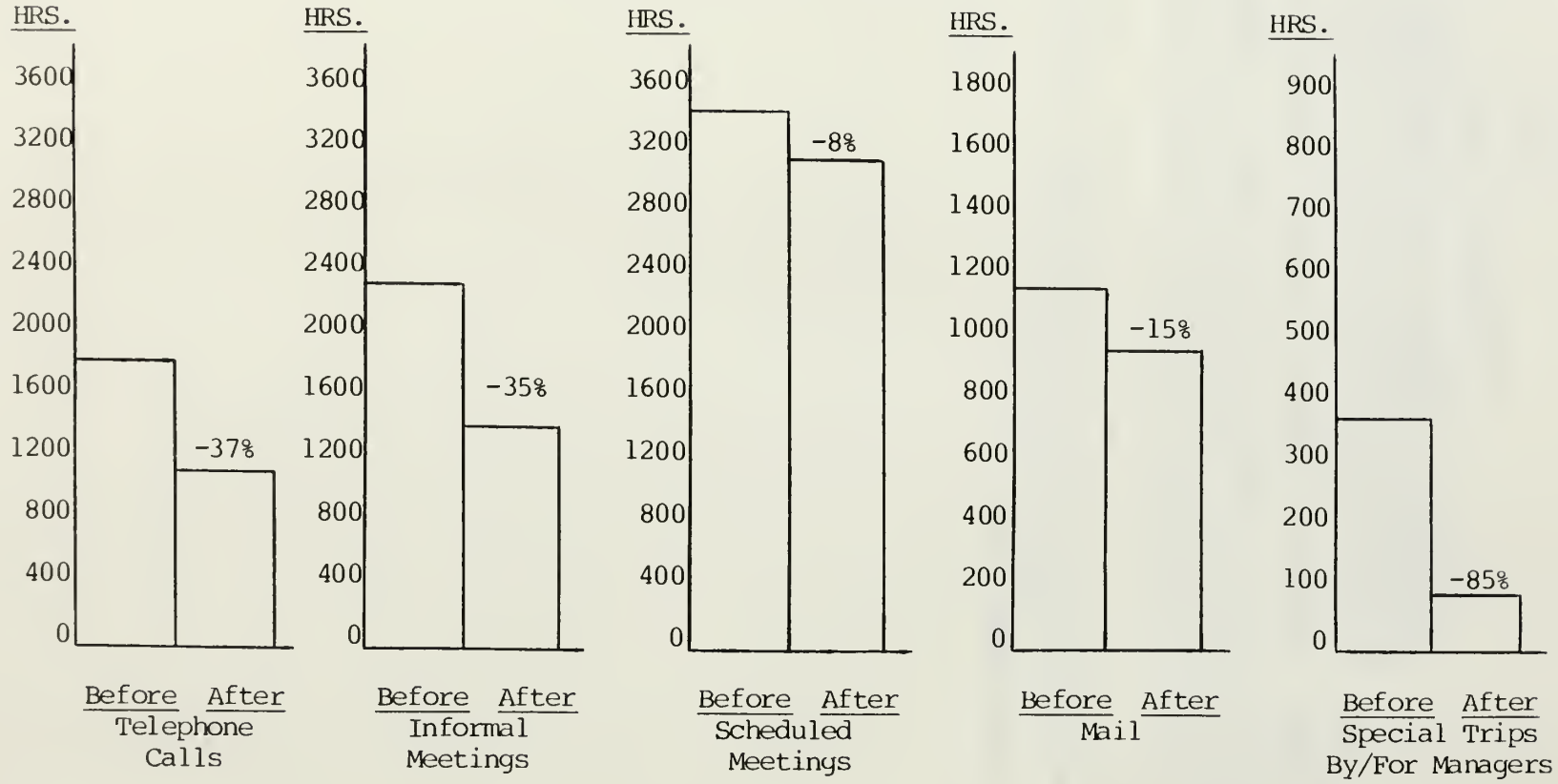
Table 1, Table 2, and Table 3 are graphic illustrations of estimates made by the Maddox Group to illustrate the opportunities to automate various office functions at NWC China Lake (Maddox, February 1981).

Pages 73 through 77 of this Appendix are taken from the ATIPS Concept Development Paper (NWC, March 1982).

TABLE 1

POTENTIAL HOURS SAVED EACH MONTH PER ACTIVITY

Managers/Administrators



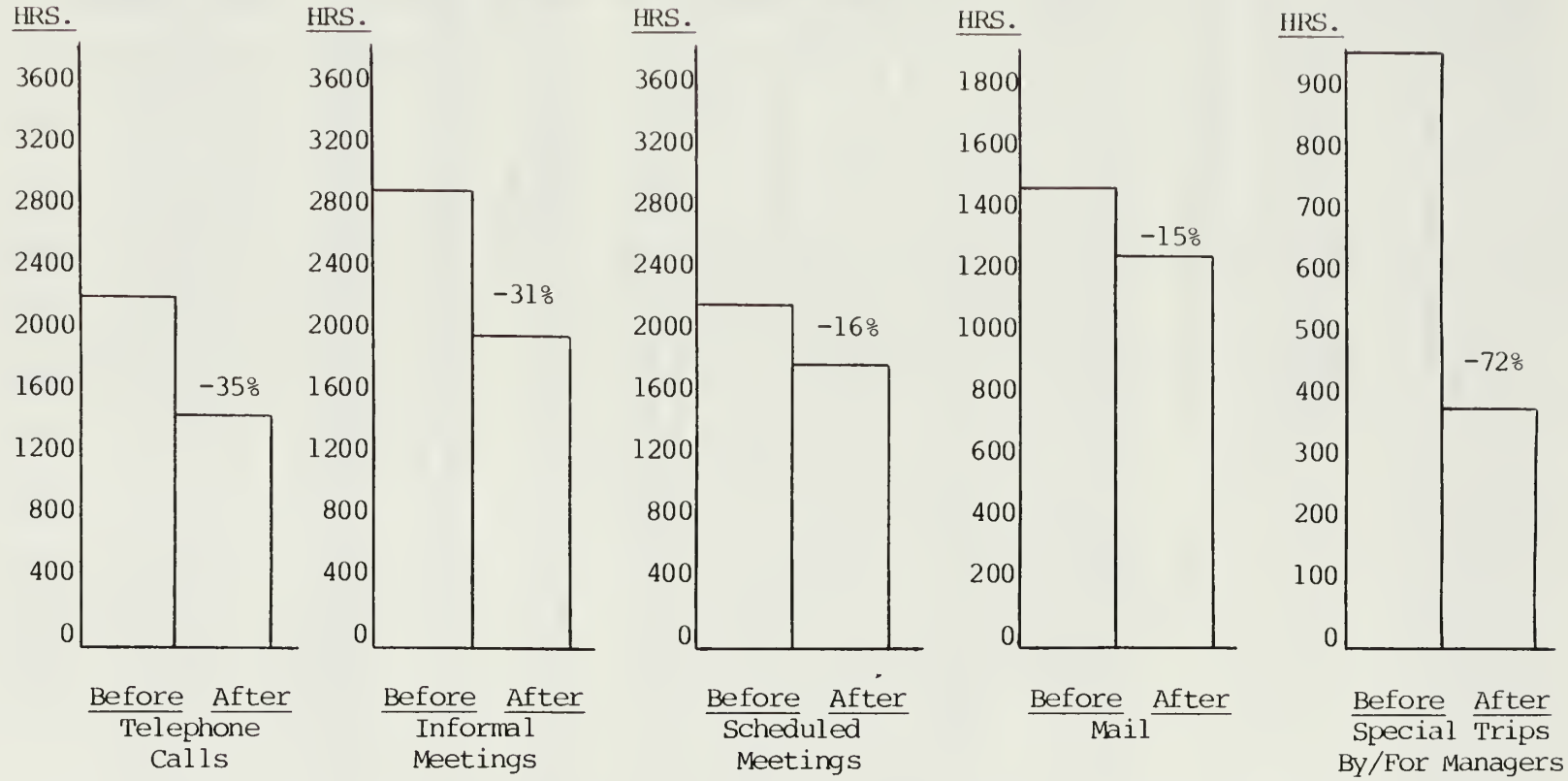
(The figure in the "after" column represents the projected percentage of change in the hours spent on each activity after automation.)

(Maddox, February 1981)

TABLE 2

POTENTIAL HOURS SAVED EACH MONTH PER ACTIVITY

Technical/Technical Administrators



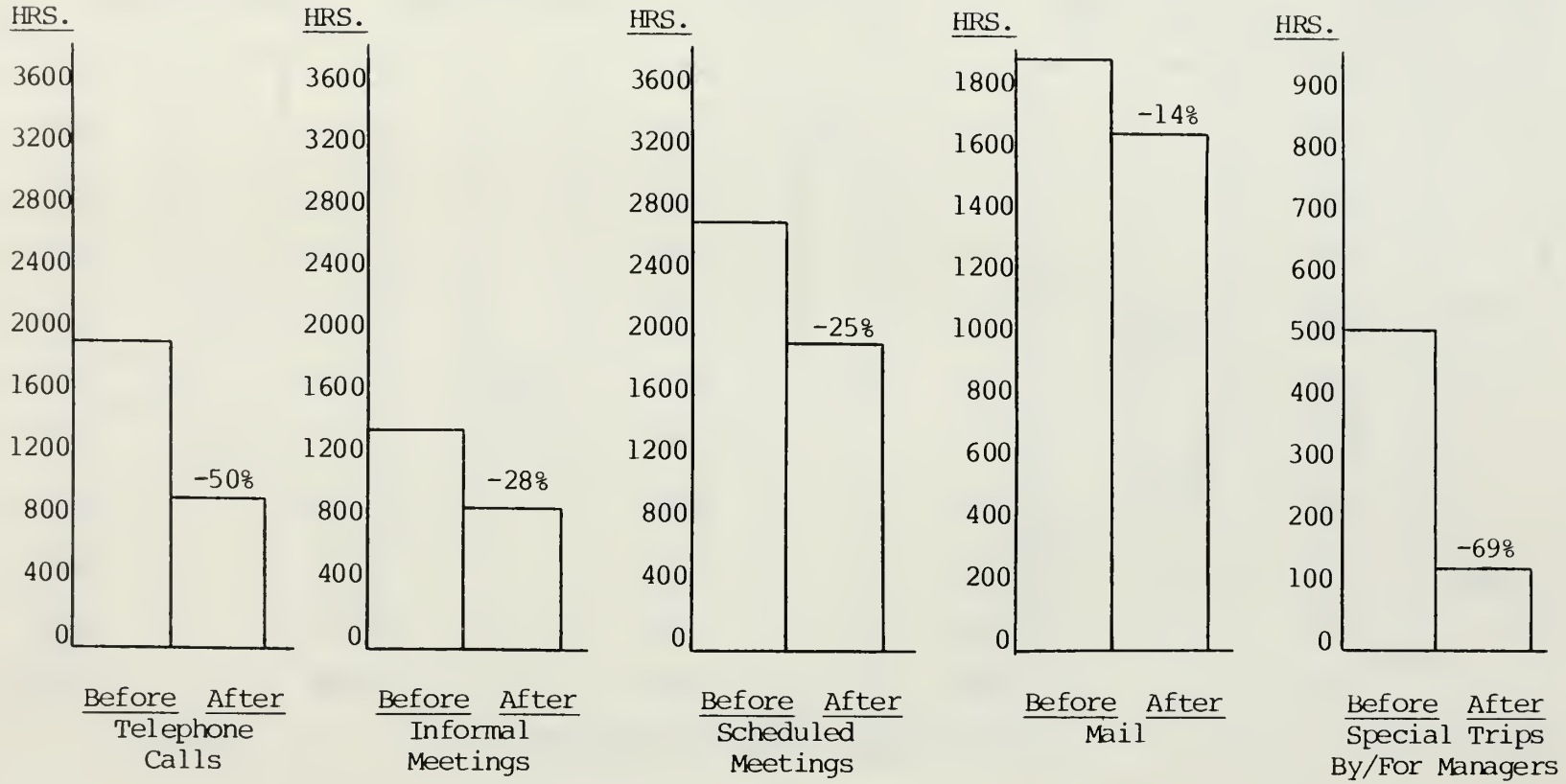
(The figure in the "after" column represents the projected percentage of change in the hours spent on each activity after automation.)

(Maddox, February 1981)

TABLE 3

POTENTIAL HOURS SAVED EACH MONTH PER ACTIVITY

Support



(The figure in the "after" column represents the projected percentage of change in the hours spent on each activity after automation.)

(Maddox, February 1981)

1. Personnel Costs. Direct costs are the salaries of personnel required to operate the ATIPS. The salary schedule for a technician is averaging $25,951 annually. For the purposes of this economic analysis, the figure of $25,951 was inflated by 9 percent to account for cost of living increases between FY81 and FY82, adjusted by 10 percent to account for cost of living increases between FY82 and FY83, then adjusted by 31 percent to conform to the guidelines set forth by the A-76 Cost Comparison standards.

Average salary for FY81 = $25.9 K
Average salary for FY82 = $28.3 K
Average salary for FY83 = $31.1 K
Adjustment prescribed by A-76 31 percent

Total adjusted average
technician salary = $40.7 K

The adjusted salary of $40.7 K is used as the salary of the ten personnel who are required for the operation of ATIPS. This staff will be used to operate and maintain the system, perform restart and recovery, and if time permits, training and helping users become familiar with ATIPS.

2. Maintenance Costs. Maintenance costs will not be incurred in FY83, since it is assumed that the first increment of the ATIPS will not be functional until FY84. Monies will be committed during the fiscal year requested, but delivery of hardware will be staged over time to facilitate installation and training. Annual maintenance costs are predicated on estimated maintenance contract costs of $250 per terminal, $5,000 per processing unit, and $10,000 per shared resource. The first increment of ATIPS (FY84) will require 60 terminals, three processors, and one OCR for a maintenance cost of $40,000. Costs in FY85 reflect the use of an additional 480 terminals, 10 processors, one OCR, and one printer for an annual cost of $230,000. Costs for FY86 include the third increment of 540 terminals, 11 processors, one OCR, and one printer at an annual maintenance cost of $440,000. Costs for FY87 include the fourth and final increment of 540 terminals, 11 processors, one OCR, one quality printer, and one video disc at an annual maintenance cost of $660,000.

3. Other Costs. Other costs include the annual costs for supplies (paper, ribbons, printwheels, etc.), equipment and building rental, if applicable, and for utilities (electric, heat, etc).

4.2.5.2 ATIPS Benefits. Benefits are both quantitative in dollar savings and qualitative in terms of a more timely higher quality product.

a. Quantitative Benefits. Quantitive benefits are derived from calculating dollar savings attributed to the more efficient operation provided by ATIPS, resultant cost avoidance savings and reduced expenditures of the current system.

1. The results of a requirements analysis performed by The MATTOX Group in December 1980 through February 1981 at NWC, shows that ATIPS will result in a 20 percent savings in time. This savings will result in additional time being made available to a staff member to work on projects and is converted to cost savings by multiplying the 20 percent factor against the persons salary

(including all benefits). This value agrees with information from other similar office automation projects from both Government and industry and is felt to be conservative. Increases in efficiencies far above this 20 percent value have been reported in well organized and scheduled office automation activities. Industry publications indicate typical productivity increases of from 10 percent to 30 percent using available systems. Amoco Production Research Co. claims a 60 percent increase in the productivity of its personnel. Booz, Allen, and Hamilton estimates a 20 percent increase in productive time with the adoption of new office automation technology with the greatest payoff coming to senior managers in the form of enhanced decisionmaking. For the purpose of calculating cost avoidance based on the 20 percent savings, an average weighted salary (average of all salary classes including benefits in FY83 dollars) of $43.8 K is used.

2. This value is obtained by proportionally averaging the number of members in each job category times their salaries. These salaries for each job category are: Scientist and Engineer ($35,241), Technicians ($25,950), Clerical ($14,077), and Administrative ($26,634). The resultant average of $27,876 is then inflated by 9 percent to account for cost of living increases between FY81 and FY82, and by 10 percent for FY82-FY83 increases, and adjusted by 31 percent to conform to the guidelines set forth by the A-76 Cost Comparison Standards for benefits.

Average salary for FY81 = $27.9 K
Average salary for FY82 = $30.4 K
Average salary for FY83 = $33.4 K
Adjustment prescribed by A-76 31 percent

Total adjusted average
salary = $43.8 K

3. In FY85, it is estimated that 650 employees will potentially be affected by ATIPS from bringing on line 540 terminals and will realize an increase in efficiency of 20 percent at a cost avoidance savings of $5.7 M. This estimate of the relationship of employees to terminals is based on the known synergistic effects that come about through social interaction between employees (e.g., roommates sharing a terminal exchange information to the gain of each). In FY86 an additional 950 personnel will potentially be affected by ATIPS from adding an additional 540 terminals. This results in an additional savings of $8.3 M or a cumulative annual cost avoidance savings of $14 M. In FY87 an additional 540 terminals will be added providing use to an additional 900 personnel. This results in an additional savings of $7.9 M or a cumulative annual cost avoidance savings of $21.9 M. This annual savings will be the same for the remaining 5 years since no further terminals are anticipated after FY87 as a part of this purchase. Labor savings due to cost avoidance over the first 8 years of ATIPS in constant FY83 dollars is $151 M. These savings are broken out for each year over the system's life cycle and are shown in Figure 4-7.

	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91	FY 92	TOTAL
ONE TIME COST AVOIDANCE FOR NEW EQUIPMENT	322									322
COST AVOIDANCE SAVINGS		5,700	14,000	21,900	21,900	21,900	21,900	21,900	21,900	151,100
OFF CENTER TRAVEL SAVINGS		420	840	1,260	1,260	1,260	1,260	1,260	1,260	8,820
MAINTENANCE COSTS AVOIDED		200	400	600	600	600	600	600	600	4,200
OFF CENTER TRAVEL (TIME)		70	140	210	210	210	210	210	210	1,470
TOTAL UNDISCOUNTED	322	6,390	15,380	23,970	23,970	23,970	23,970	23,970	23,970	165,912
DISCOUNT FACTOR	.954	.867	.788	.717	.652	.592	.538	.484	.445	
TOTAL DISCOUNTED	307	5,540	12,119	17,186	15,628	14,190	12,896	11,601	10,667	100,134

ATIPS Cost Savings at 20% Productivity Index Rate ($000)

4. Other dollar savings can be achieved through a reduction in the travel budget made possible by the enhanced communications of ATIPS, reduction in the current maintenance costs of the status quo system, and reductions in costs for the Center distribution system (vehicle maintenance and operations costs). A breakout of these potential cost savings in FY83 dollars shown below are as follows:

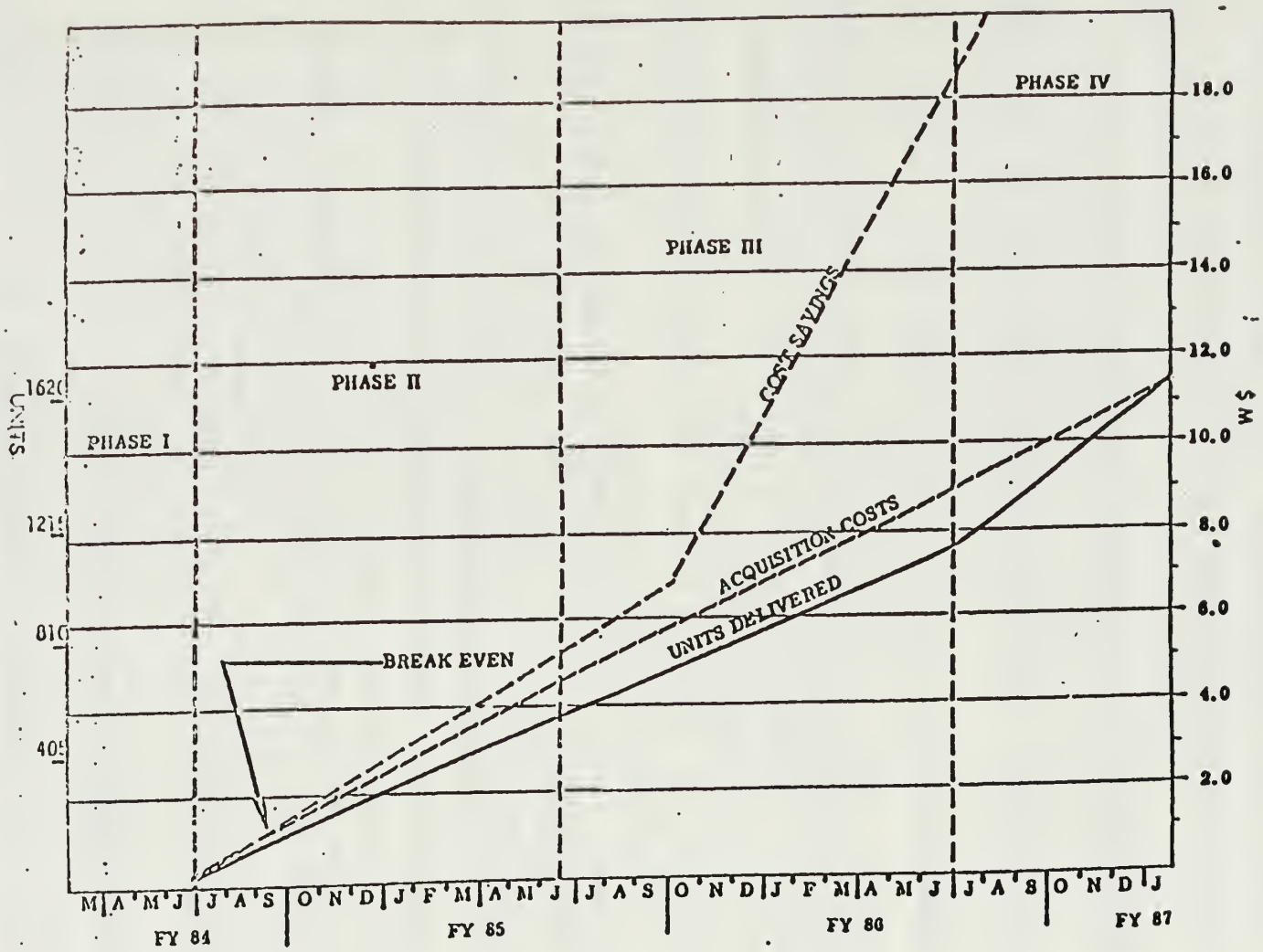
COST SAVINGS ELEMENT	LIFE-CYCLE COST SAVINGS
1. Off Center Travel	$8,820 K
2. Maintenance Costs of Office Equipment	$4,200 K
3. Off-Center Travel Time	$1,470 K

5. The above savings in travel are attributed to an estimated 15 percent reduction in traveling requirements made possible by the enhanced communications of ATIPS, allowing S&E's to communicate with off-Center personnel, data bases, and libraries, etc. NWC averages 7,000 trips per year in off-Center travel at an average cost per trip of $1,200. The study estimates that approximately 15 percent of this travel can be saved each year through the use of ATIPS. This amounts to $420 K the first year ATIPS is fully operational. Using FY83 dollars, the life-cycle (8 years) cost savings realized amount to $8,820 K.

6. It is expected that savings will result from a reduction of time spent in a travel status. Assuming one day of lost time for each of the trips avoided above the savings the first year would be $70,000 and $1,470,000 for the 8 years.

7. Savings of the current maintenance results from decreased wear through less usage on such items as copiers, typewriters, and other office equipment. During FY 80, for example, NWC spent $260 K to maintain office equipment, $20 K per month on copy machine paper and $600 K on copy machine rentals. In the same period, $110 K worth of new word processing equipment was purchased and $139 K was spent to lease word processing equipment. These figures were converted to FY83 dollars and it is assumed that 50 percent of the related cost can be avoided.

8. Additionally, it is expected that there will be a cost avoidance of $322 K (FY83 dollars) in FY84 in that the Center will defer anticipated purchases of office supplies and equipment to wait for ATIPS to supply the necessary capability. The savings due to cost avoidance over the expected 8-year life cycle of the ATIPS project total is $166 M, and is plotted by installation phase in Figure 4-8. This graph shows the acquisition costs and the total cost savings as the equipment is installed and becomes operational. A very early break even point (3 months) is shown. However, a payback period of 1.25 years (the inflection point in the cost savings line) is claimed based on the sensitivity of the estimated 20 percent productivity index rate.


PHASE IV
PHASE III
PHASE II
PHASE I
COST SAVINGS
ACQUISITION COSTS
UNITS DELIVERED
BREAK EVEN
UNITS
1620
1215
810
405
$M
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J
FY 84
FY 85
FY 86
FY 87

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